

Making Mars Affordable

Lower Tech, Lower Risk, Near-Term First Missions

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What is Affordability?



Humans to Mars



- It is unlikely that significant increases in the NASA budget (adjusted for inflation) would be approved
 - A small increase might be possible if a compelling set of missions could be offered within a political time horizon of interest
- SLS and Orion are funded programs that are likely to continue
 - They should provide a source of regular flights at a known utilization rate (i.e. 2 SLS launches per year)
 - Utilize them. Don't count them in the cost of the H2M Program.
 - e.g. ISS was a separate line item from the STS
- An example of an affordable and sustainable program is the ISS
 - Staying within the historical annual cost of ISS (adjusted for inflation) would be a good metric for affordability
 - A big part of “Sustainability” is being within an acceptable annual budget
 - And...public excitement, national achievement, and exploration and science value must be high enough justify the cost

The Path to Affordability



Humans to Mars



- Mars is hard. Don't make it any harder than you have to.
 - **Just do the things you have to do** to make the first missions safe and successful
 - One approach would be to minimize new technology development and risk
 - e.g. use traditional bipropellants for in-space propulsion and landers
 - Minimize complexity to reduce development and in-flight risk
 - Minimize the number and scope of new vehicle developments
 - The first missions could be **near-term** exploration missions to lay the groundwork for more capable and extensive follow-on missions
 - **Don't do all the fancy stuff on the first mission.** Keep developing the more difficult, higher performance capabilities to be on-ramped later after risks of the initial missions have been retired.
 - Reusability is complex and has significant up-front costs and risk. Reusability could be added after lessons learned from several flights to fix any design flaws, and after long-term reliability is understood from flight experience.
 - ISRU could be added later, when you have a business case and can afford it
 - **Leverage new commercial capabilities as they become available**